Laser ablation of lysozyme with UV, visible and infrared femto- and nanosecond pulses

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Laser ablation of the protein lysozyme with pulses in the UV, visible and infrared regime by nanosecond and femtosecond lasers.

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Lysozyme is an interesting molecule for laser ablation of organic materials, because the ablation has been comprehensively studied, it is a medium heavy molecule with a mass of 14305 Da, which can be detected by standard techniques, and because it is used as a bactericidal protein in the food industry. Lysozyme molecules do not absorb energy for wavelengths above 310 nm, but nevertheless there is a strong mass loss by ablation for laser irradiation in the visible regime. The total ablation yield of lysozyme at 355 nm and at 2 J/cm^2 is about 155 µg/pulse, possibly one of the highest ablation yields ever measured. The mass loss is mainly caused by fragmentation of the lysozyme into simple gases, such as H_2S, H_2O and CO_2 , which are rapidly pumped away in the vacuum chamber.

We have investigated the mass loss by ablation of lysozyme in all regimes to see whether a similar mechanism governs the ablation process for different wavelengths and time duration. Measurements for 6-7-ns laser ablation were carried out at DTU on Risø Campus, while measurements with pulses of 300 fs were carried out at the University of Naples in a similar setup. For all wavelengths except at nanosecond laser pulses at 355 nm, the efficiency of ablation is similar, about 0.02 g/J. Material deposited as films was investigated by MALDI (Matrix Assisted Laser Desorption) in order to check whether or not intact lysozyme molecules were transferred from target to the substrate. The experiments have confirmed that fragmentation of lysozyme into gases via photothermal processes drives the ablation at most wavelengths.